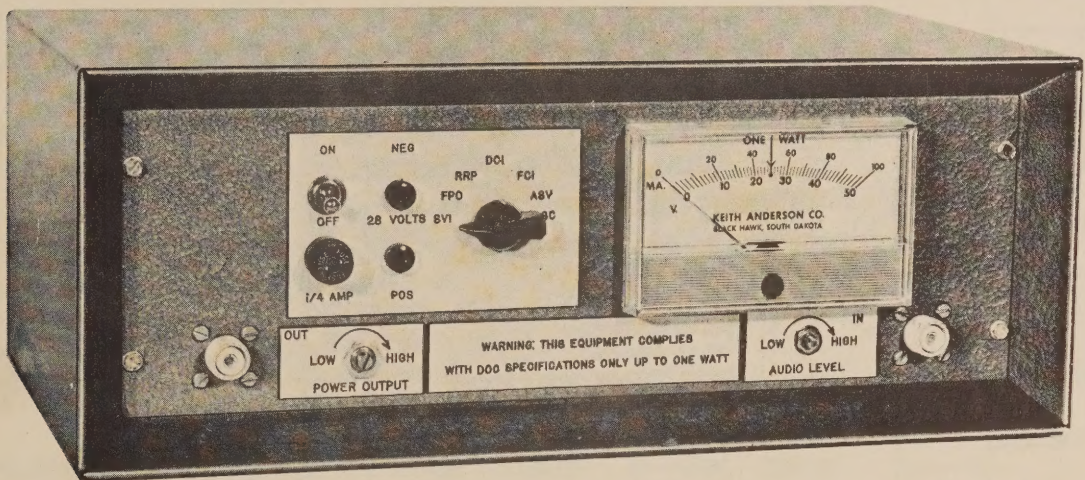


OWNER'S MANUAL



T-99

ONE WATT

TRANSISTOR TELEVISION TRANSLATOR

KEITH ANDERSON CO.
BLACK HAWK, SOUTH DAKOTA

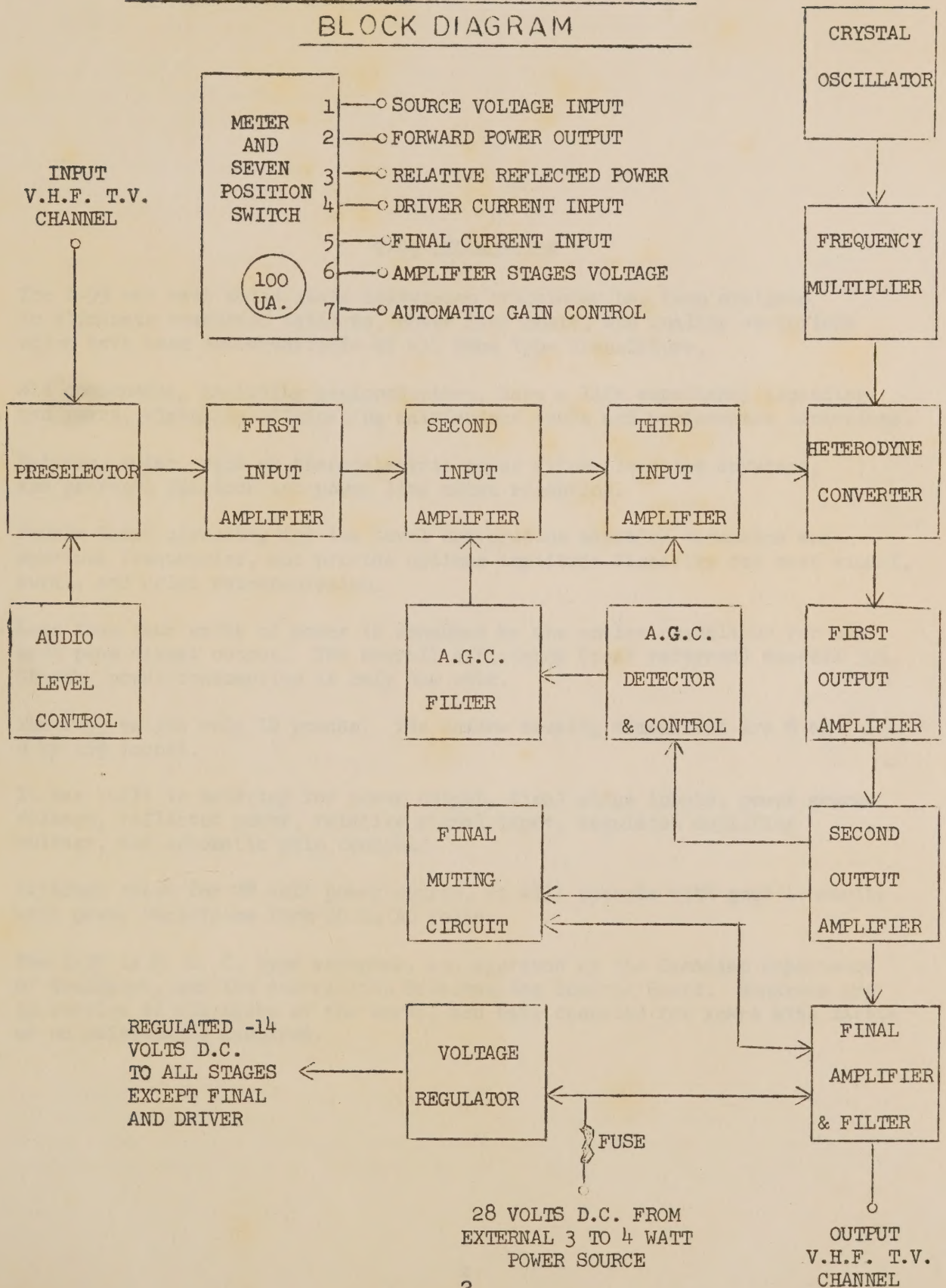


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T-99 OVERALL OPERATION

BLOCK DIAGRAM



T-99 DESCRIPTION

The T-99 one watt solid state television translator has been designed to eliminate component failures, power line costs, and quality variations which have been characteristic of all tube type translators.

All components, including semiconductors, have a life expectancy exceeding ten years, virtually eliminating maintenance costs and performance variations.

Battery, solar, wind or thermoelectric power allows location anywhere, and prevents ignition and power line noise reception.

Double tuned circuitry and low level conversions minimize harmonics and spurious frequencies, and provide optimum amplitude linearity for best visual, aural, and color retransmission.

Less than four watts of power is consumed by the entire translator for one watt peak visual output. The overall efficiency (peak referred) exceeds 30%. Standby power consumption is only one watt.

The T-99 weighs only 12 pounds. The shadow housing dimensions are 6 by 9 by $15\frac{1}{2}$ inches.

It has built in metering for power output, final stage inputs, power source voltage, reflected power, relative signal input, regulated amplifier voltage, and automatic gain control.

Although rated for 28 volt power source, it will operate with good linearity with power variations from 20 to 30 volts.

The T-99 is F. C. C. type accepted, and approved by the Canadian Department of Transport, and the Australian Broadcasting Control Board. Hundreds are in service in all parts of the world, and have operated for years with little or no maintenance required.

T-99 OVERALL OPERATION (CONT.)

1. PRESECTOR. This tuned reactive network provides impedance match, selectivity, and reactance cancellation into the first amplifier. It is precisely matched for 75 ohm inputs.

The receiving antenna should match a 75 ohm input cable and should be selective and directive. Input to the preselector should never be less than 100 microvolts, nor exceed 5000 microvolts.

An audio level control is incorporated into the preselector. This allows reduction of the incoming aural carrier in areas where propagation conditions produce excessive audio at the input terminals. Best translator operation is obtained when the aural carrier is adjusted for about 12 dB. below the visual peak value.

2. FIRST INPUT AMPLIFIER. This stage utilizes a low noise V.H.F. transistor. Typical noise figure is from 4 dB. at 60 mc. to 5 dB. at 200 mc. This yields an overall noise figure for the translator of about 5 dB. with low channel inputs and 6 dB. with high channel inputs. This is a considerable improvement over the frame grid tubes incorporated in earlier translators, and enables the translator to deliver good quality pictures in low noise reception areas with inputs down to 100 microvolts at 75 ohms.

3. SECOND INPUT AMPLIFIER. This stage is A.G.C. controlled to enable the mixer to operate with uniform signal input levels. Automatic gain control action is achieved by the "forward" method. An increase in collector current decreases the stage gain. This allows over 20 dB. of A.G.C. per stage without sacrificing power handling ability or linearity. Tuning of the double tuned circuitry is relatively independent of the transistor's collector current and gain variation, allowing uniform frequency response with variations in A.G.C. control action.

On a few of the harmonically related conversion such as Channel 6 to 7 (U.S.) excessive spurious emissions are eliminated by utilizing V2 as a first converter and V3 as an I.F. amplifier. All characteristics remain the same as with direct conversion, with the exception of frequency accuracy, which is improved by utilizing matched pairs of crystals with similar calibration deviations.

4. THIRD INPUT AMPLIFIER. This is an automatic gain controlled stage identical to the second input amplifier. The combined stages provide A.G.C. control of 40 decibels. All stages have double tuned coupling circuitry. All voltage amplifiers are Class A.

5. HETERODYNE CONVERTER. The amplified input channel is applied to the base of the silicon mixer, along with the output of the frequency multiplier. The output of the converter is the sum or difference of these frequencies depending upon the frequencies of the input and output channels.

T-99 OVERALL OPERATION (CONT.)

6. CRYSTAL OSCILLATOR. This utilizes a third or fifth overtone crystal with collector to base series resonant feed back. The crystal is calibrated by the manufacturer in an identical circuit at 20 degrees centigrade. The manufacturer guarantees a calibration accuracy of .0025% and a maximum variation of .005% from minus 55 degrees to plus 90 degrees centigrade. This .0075% maximum variation is well within U.S. requirements, and better accuracy will be supplied for special application or export units.

7. FREQUENCY MULTIPLIER. This stage acts as a non-linear amplifier with double tuned output to select double, triple, or the crystal oscillator frequency. With channel conversions of less than 40 mc. frequency difference, the stage is a buffer. On all others it is a multiplier. The high selectivity coupling circuit to the mixer is important to prevent image conversions from harmonic injections. Mixer injection can be controlled for optimum gain and linearity by slight detuning of this coupler.

The oscillator and multiplier are fully enclosed within a separate shielding. This is in turn mounted in a double enclosed chassis. Feed thru capacitors provide power to the stages for maximum bypassing. This combination eliminates all measureable spurious radiation from the housing and receiving antenna.

8. FIRST OUTPUT AMPLIFIER. This is a silicon Class A stage at the output channel frequency. It is operated with more input power than earlier stages to provide good linearity at the higher signal level.

9. SECOND OUTPUT AMPLIFIER. This driver stage delivers 1/10 watt peak visual to the input of the final. Peak visual level is detected in the collector circuit for automatic gain control. Level of action of this peak responsive A.G.C. is adjusted by the power output control.

10. FINAL OUTPUT AMPLIFIER. The class A B final has a base bias circuitry which has been experimentally derived for optimum amplitude linearity. It retains input modulation characteristics within 5% at the output, and operates with a peak referred efficiency of approximately 50%. This stage is the heart of the efficient translator performance. It enables a higher quality rebroadcast than tube units requiring fifty times the supply power.

11. OUTPUT CHANNEL FILTER. This incorporates a quadruple tuned circuit with two high capacitance-parallel resonant circuits at low z for shunting of harmonics, and a highly selective double tuned circuit at critical coupling. A trap is for the lower intermodulation product (at visual carrier minus 4.5 mc.). Forward and reflected power metering detectors are at the output of the filter. Output impedance match and reactance neutralization is adjusted for 75 ohm match by the relative inductance of the filters input and output parallel resonant circuits. This is, in effect, a modification of pi match with the excess value of fixed capacitances resonated against variable inductors.

T-99 OVERALL OPERATION (CONT.)

12. AUTOMATIC GAIN CONTROL is R-C filtered and amplified. This yields a smooth D.C. for base bias current increase in the controlled stages. Multiple filtering is necessary because of the detection of peak combined visual and aural during sync. periods only. This peak detection assures that peak output remains constant during modulation variation of received signal. The combined detection feature prevents excessive audio power output during periods of selective fade due to temperature and humidity variations along the received signal path. Selective fade is also produced by mulitpath phase cancellation of carrier by aircraft reflections.

13. FINAL MUTING is accomplished by reverse bias of the base. This gives collector current cutoff and better "muting" than simply switching collector power off. The reverse bias approach removes charge carriers from the base boundary region, creating a more effective open R.F. circuit.

The action is achieved by a bistable dual bias network which operates as a function of the current utilized by all stages before the final. A signal increases current to the driver and A.G.C. stages causing the final base to bias for normal operation. During no signal operation (stand by), the base is reverse biased. Momentary noise pulses from lightning or ignition are prevented from activating the "turn on" by the A.G.C. delay circuitry.

14. VOLTAGE REGULATOR is a solid stage series unit. It delivers - 14 volts regulated to all stages except the final, thus maintaining stable characteristics over a wide range of supply variations. (Units manufactured after 1966 use full supply voltage to both driver and final stages.) A zener diode maintains the regulator base bias for a constant emitter voltage of - 14 volts.

15. METER AND SWITCH. All major functions are monitored by a single 100 microamp meter and a seven position switch. Power output is factory calibrated by positioning the forward power detector for one watt reading while operating into a 75 ohm load and calibrated external meter.

The current input-monitors for the driver and final enable a secondary check on the power output based on the typical efficiency and the input power. Final currents have some variation with modulation, increasing with blacker pictures.

The amplifier stage voltage metering checks for proper operation of the supply regulator.

A.G.C. metering will give indication of the relative input. Reading is decreased by increasing signal level. It will read about mid-scale when the unit is operated with the ideal 1 millivolt input level. This switch position may be used to "home-in" directional receiving yagis or to phase multiple arrays.

T-99 TECHNICAL SPECIFICATIONS

INPUT FREQUENCY	ANY V.H.F. T.V. CHANNEL
INPUT LEVEL	100 to 5000 MICROVOLTS AT 75 OHM. (R.M.S. OF PEAK VISUAL)
OUTPUT FREQUENCY	ANY V.H.F. TV CHANNEL NOT AD- JACENT TO INPUT
OUTPUT LEVEL	ONE WATT PEAK SYNC. VISUAL .1 WATT AURAL
EMISSION TYPES	
VISUAL	A5 (AM)
AURAL	F3 (FM)
SPURIOUS OUTPUTS	
HARMONICS	AT LEAST 66 DB BELOW VISUAL
OTHERS	AT LEAST 40 DB BELOW VISUAL
AUTOMATIC GAIN CONTROL	40 DB FOR 2 DB OUTPUT VARIATION 30 DB FOR 1 DB OUTPUT VARIATION
IMPEDANCE	75 OHMS INPUT AND OUTPUT COAXIAL (UNBALANCED)
CONVERSION ACCURACY	U. S: WITHIN .01% OF OUTPUT VISUAL CARRIER EXPORT: TO REQUIRED ACCURACY
POWER REQUIREMENTS	28 VOLTS 3.5 WATTS (TRANSMIT) 28 VOLTS 1 WATT (STAND BY) (30 VOLT, 4 WATTS OPTIONAL)
AMBIENT TEMPERATURE	-40 DEGREES TO +60 DEGREES CENT- IGRADE -40 DEGREES TO +140 DEGREES FAH- RENHEIT
DIMENSIONS	6 BY 9 BY 15 $\frac{1}{2}$ INCHES.
WEIGHT	12 POUNDS
METERING	SUPPLY VOLTAGE, POWER OUTPUT, REFLECTED POWER, DRIVER CUR- RENT, FINAL CURRENT, REGULATED VOLTAGE, AUTOMATIC GAIN CONTROL

T-99 CONVERSION FREQUENCIES
(U.S.A. CHANNELS)

									13
									12
									11 D
									18
									10 D 18
									18 24
									9 D 18 24
									18 24 30
									8 D 18 24 30
									18 24 30 36
									7 D 18 24 30 36
									49 52 55 58 61 64
									6 98 104 110 116 122 128
									49 52 55 58 61 64 67
									5 98 104 110 116 122 128 134
									16 54 38 40 42
									4 16 108 114 120 126 D D D
									16 22 38 46 48 75
									3 16 22 114 D D D 138 144 150
									22 42 44 46 48 75 78
									2 D 22 D D 126 132 138 144 150 156

Upper number is oscillator frequency, lower is mixer injection frequency, in megacycles. "D" signifies dual conversion required with intermediate frequency chosen for optimum at intended reception site.

Conversions between numerically adjacent channels are available only with separate pre-converter.

T-99 METERING				
POSITION	INDICATES	READING		
		WITHOUT INPUT SIGNAL	READING WITH INPUT SIGNAL	SCALE
SVI	Source voltage input	28	28	V
FPO	Forward Power output	0	1 watt	Cent.
RRP	Relative Reflected power	0	5 max.	Rel.
DCI	Driver Current input	5	10-30	MA
FCI	Final Current input	0	50-90	MA
ASV	Amplifier Source Voltage	14	14	V
AGC	Automatic Gain Control	75	75-20	Rel.
			(50 optimum)	

T-99 INSTALLATION NOTES

1. EQUIPMENT HOUSING

The equipment should be housed in a dry, weatherproof, and temperature stabilized container. No ventilation is required, for less than three watts heat is dissipated.

Several installations have incorporated discarded refrigerators for either surface or burial mount. A large metallic mass within the insulated area will "smooth out" temperature variations to minimize thermal stresses on components and leads.

2. POWER SOURCE

Four heavy duty 6.3 volt truck batteries in series are the most economical power source for easily accessible sites. These should be recharged every month to assure maintenance of full supply voltage. Partial burial will stabilize temperature and performance and increase battery life.

For remote locations, thermoelectric powering has proven most ideal. It is not subject to the variations of wind recharging. No batteries are involved, since the thermoelectric converter delivers a regulated, well filtered, 28 volts output. A single flame, with no moving parts, provides the energy source. One 250 gallon tank of propane will operate the translator for a year.

A.C. powering is recommended only where the translator replaces obsolete tube type in existing locations. Most power lines radiate V.H.F. interference, and increase possibility of lightning damage to the external power supply.

3. RECEIVING ANTENNAS.

One to four single channel yagi type antennas should be used, depending upon the received signal level, and the directivity required to cancel interference from noise sources or co-channel and adjacent broadcast stations or translator.

5 or 8 element yagis are recommended for low channels, 10 or 12 element for high. This is the maximum for good gain with full constructional stability.

We will supply matching cables and instructions to phase out interference.

As a general rule the input antenna should be located about 100 ft. from any transmitting antennas. This is especially important where more than one translator is installed at a site, and when the output channel is close to the received frequency. Some single translator installations can space antennas closer, but transistors operate with low power input, and are more subject to overdrive than tubes. Most multiple installations may require supplemental trapping.

T-99 INSTALLATION NOTES (CONT.)

4. TRANSMITTING ANTENNAS.

These should be five element yagis on the low channels, and five or ten element on the high. They may be directed together to cover a long narrow pattern or staggered up to 90 degrees between each antenna for other coverage applications.

Use of more than four output antennas usually is of little advantage, because of phase cancellation losses.

We will recommend the best antenna spacing and directing for a particular coverage need, and design the matching cables.

5. PREAMP. Inputs of under 200 microvolts at 75 ohms should use a preamp to provide fade margin. This may be remotely powered and located at the receiving antenna to improve the signal to noise ratio. The preamp must be transistorized and single channel.

6. RECEPTION SITE must be chosen for the best input and minimum interference. Often this is just off the "brow" of a hill rather than on top. The antennas should be directed for maximum signal. This is usually down the hill slope, and not horizontal. Large towers are normally not necessary, and may only increase maintenance problems. Most installations have their individual engineering considerations. We will assist with the initial planning and in any other phase.

7. Where a remote shut off is required, we offer a wire controlled external unit. It is "fail safe", and incorporates a meter at the remote switch which doubles as a remote power voltage check point.

8. CONTROL LEVELS. Never operate the power output at over one watt. This would be in violation of F.C.C. rules, and will not deliver better coverage or improved quality, for the black levels would compress and sync. would be unstable.

The units may be operated at less than one watt when licensed accordingly. This conserves battery power and will often be fully satisfactory for small communities.

Audio level should be adjusted for sound 12 dB. down from visual at the output. If no R.F. meter is available, adjust for the minimum level which delivers good quality sound to the receivers in the community.

T-99 MAINTENANCE NOTES

A. The T-99's which have been in operation for several years in most western states and several countries from the Equator to Alaska have required practically no maintenance.

Correct operation should be verified by a yearly check of the meter positions. In the unlikely event of a transistor failure, the stage can be located by direct current analysis. A V.T.V.M. check of voltage across each emitter resistor checks for shorts or opens. The drop is always less than 2.5 volts for all stages (with no signal input). Final and driver are less than .1 volt.

B. Lightning damage is very unlikely, because a direct current short circuit is designed into the input and output terminals to cancel antenna line charges. A.C. power supplies are subject to lightning damage from the line, but all rectifiers and other components in these are operating at a fraction of their ratings. All housings and tower should be connected to a good earth ground with aluminum wire.

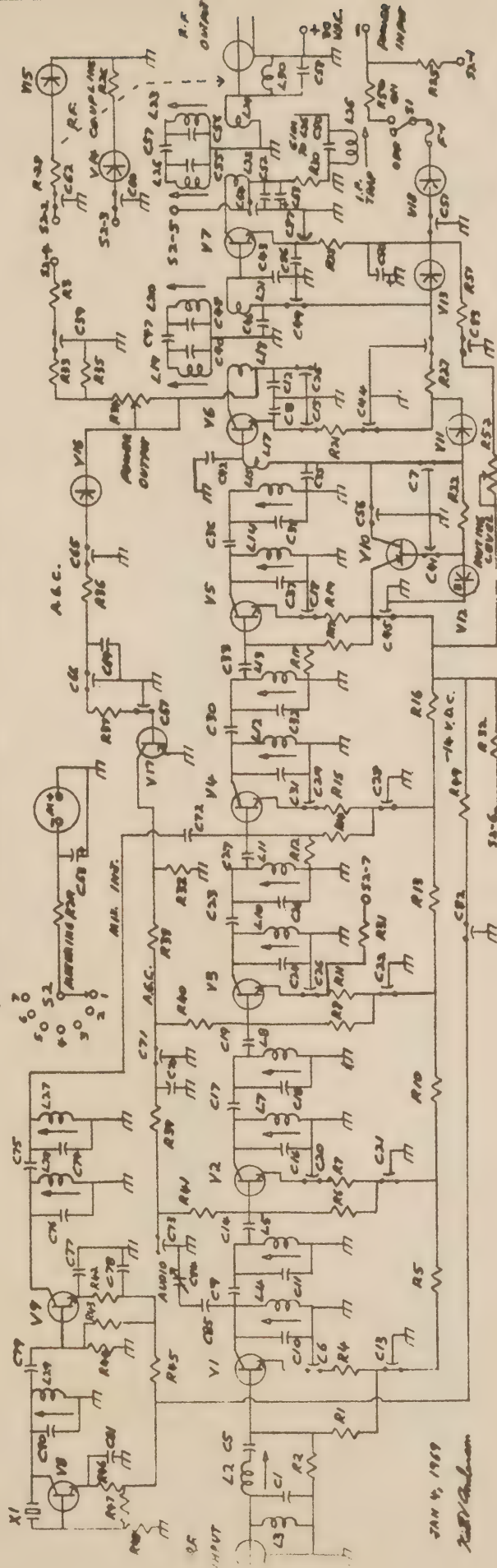
C. Because of the light weight of the T-99 (12 lbs. unit weight, about 16 lbs. shipping weight) factory service is most practical, if required. Either air or regular parcel post is most satisfactory. The units should always be double packaged to prevent shipping damage. All warranty is cancelled for equipment with any internal changes.

D. No field alignment should be attempted other than adjustment of the power output and audio levels as described in the installation instructions. Any other adjustment invalidates the warranty and guarantee.

E. The T-99 will give years of trouble free service if the following considerations are rigidly observed:

1. Be certain the housing is dry and weatherproof.
2. Keep the power source a uniform well filtered and regulated 25 to 30 volts D.C.
3. Use heavy duty yagi antennas and well sealed connectors.
(We can supply these.)
4. Fasten coax rigidly to antennas and tower - no "swinging" spans.
5. Use short, self-supporting towers, then guy them for the extra wind at elevated sites. Keep guy wires more than five feet from antennas.
6. Ground all the system components.

T-99A TRANSISTOR TRANSLATOR



JAN 4, 1969
KIST/Chelam

T-99A RESISTORS

SYMBOL	VALUE	SYMBOL	VALUE
R1	10,000	R2	47,000
R3	4,700	R4	470
R5	10	R6	100,000
R7	470	R8	100,000
R10	10	R11	470
R12	10,000	R13	100
R14	1,000	R15	270
R16	10	R17	10,000
R18	1,000	R19	56
R21	4.7	R22	2,700
R23	3.9	R25	470,000
R26	150	R27	10
R28	150	R29	100
R30	1.3	R31	150,000
R33	1,000	R34	0-500
R35	10	R36	100
R37	100	R38	100
R32	100,000	R39	100
R40	470	R41	470
R42	1,000	R43	4,700
R44	47,000	R45	100
R46	1,000	R47	4,700
R48	47,000	R49	1,000
R50	4.7	R51	470
R52	0-500		

All resistors are 1/2 watt, 10% tolerance. Power Output and muting controls are linear.

T-99A CAPACITORS

C1	22-100	C5	22-4.7
C6	FT-1000	C7	FT-1000
C8	2000	C9	.25-2.2
C10	7.5-15	C11	7.5-15
C12	2000	C13	FT-1000
C14	4.7	C15	FT-1000
C16	7.5-15	C17	.25-2.2
C18	7.5-15	C19	FT-1000
C20	FT-1000	C21	FT-1000
C22	FT-1000	C23	.25-2.2
C24	7.5-15	C25	FT-1000
C26	FT-1000	C27	4.7
C28	FT-1000	C29	FT-1000
C30	.25-2.2	C31	7.5-15
C32	7.5-15	C33	4.7
C34	FT-1000	C35	2,000
C36	.25-2.2	C37	7.5-15

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T-99A CAPACITORS (CONT.)

SYMBOL	VALUE	SYMBOL	VALUE
C38	7.5-15	C39	FT-1000
C40	7.5-15	C41	FT-1000
C42	22-50	C43	22-50
C44	FT-1000	C45	FT-1000
C46	2000	C47	.25-2.2
C48	7.5-15	C49	FT-1000
C50	50 mfd. 50v.	C51	FT-1000
C52	2000	C53	50 mfd. 50v.
C54	FT-1000	C55	7.5-15
C56	7.5-15	C57	.25-2.2
C58	22-100	C60	FT-1000
C62	FT-1000	C63	50 mfd. 50v.
C64	FT-1000	C65	FT-1000
C66	FT-1000	C67	FT-1000
C69	10,000	C70	50 mfd. 50v.
C71	FT-1000	C72	4.7
C73	FT-1000	C74	7.5-15
C75	1	C76	7.5-15
C77	470	C78	470
C79	4.7-10	C80	7.5-15
C81	470	C82	FT-1000
C83	FT-1000	C84	1 to 5 pf. variable
C85	2.2-4.7	C86	2000
C87	FT-1000		

All capacitor values are in pico farad, unless specified otherwise. Pf values are ceramic type. FT are feedthrough ceramics. Those showing range of values are fixed units with exact value dependent upon frequency.

T-99A SEMICONDUCTORS

V1	2N3291	V2	2N3291
V3	2N3291	V4	2N3291
V5	2N3291	V6	2N3664
V7	2N3375	V8	2N3291
V9	2N3291	V10	2N4918
V11	1N4004	V12	1N5246
V13	1N4004	V14	1N34A
V15	1N34A	V16	1N4004
V16	2N3906	V18	1N4004

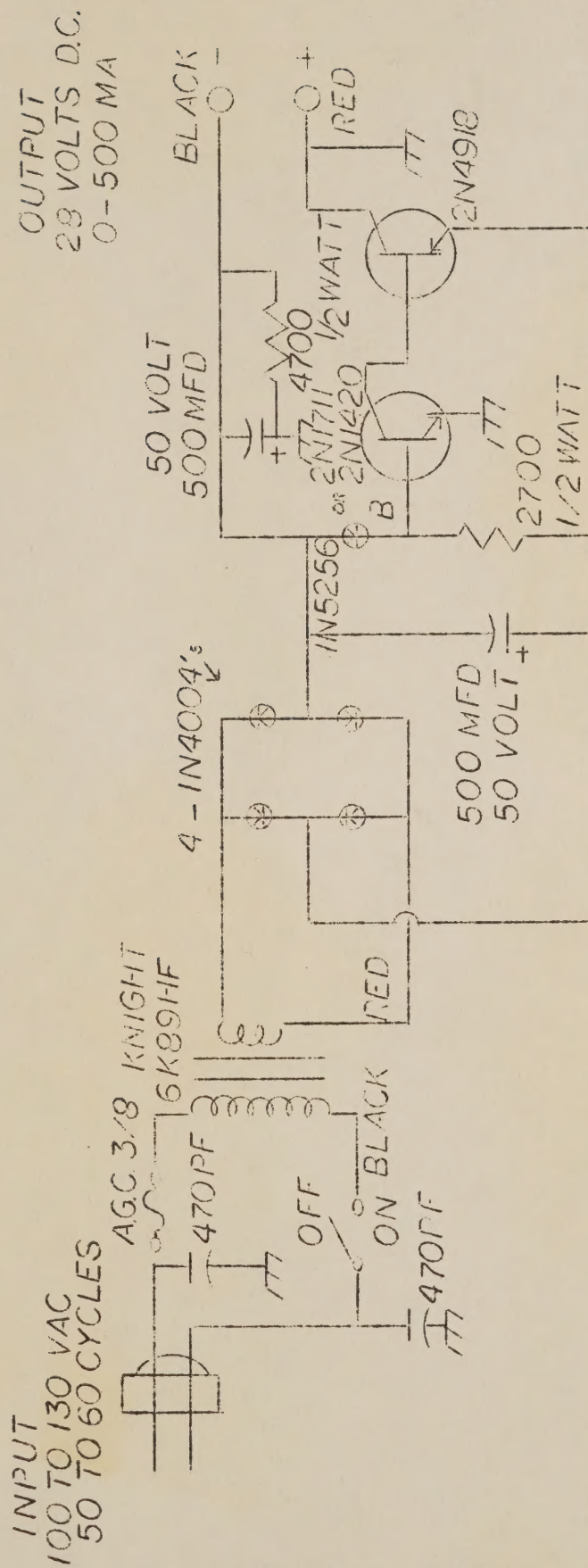
T-99A OTHER COMPONENTS

SYMBOL	DESCRIPTION
F1	1/4 Amp, A.G.C. fuse
M	100 Micro amp meter
X1	Overtone Crystal
S1	S.P.S.T. Switch
S2	Twelve position switch

When ordering components, please show component number and value, and the serial number and channels of the translator.

DC - 28 POWER SUPPLY

FOR T-99 AND T99 FM TRANSLATORS



JAN 7, 1969
Keith Anderson

